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NEW HAMPSHIRE COLLEGE
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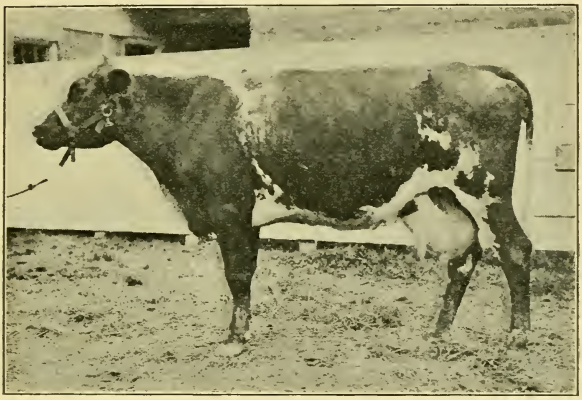
The Feeding of Farm Stock



SUE, A HIGH-GRADE SHORTHORN, N. H. C. HERD
10,000 LBS. MILK IN 1905

BY F. W. TAYLOR

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

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THE FEEDING OF FARM STOCK.

BY F. W. TAYLOR.

INTRODUCTION.

The question to the dairyman and stock feeder of how to feed his stock the most economically is the all important one. These men are not usually in the business just for their health, but for the profits, and the profits depend largely on the difference between the cost of the materials put into the animal and the selling price of the products.

During the past spring in writing a thesis for graduation on "Dairy Rations Fed in New Hampshire," student Charles S. Batchelder sent out three hundred letters of inquiry to practical dairymen and feeders in the state. As a result of these inquiries it was found that out of the two hundred who replied only thirty kept a record of the grain and only six of the hay consumed by their cows. Forty kept a record of the total amount of milk produced but only three or four had any means of knowing just what each individual cow was doing for them. In these days of sharp competition and close margins only the man who thoroughly understands his business and conducts it in a careful businesslike manner can make a financial success. Stock feeding is becoming more and more a scientific business and the man who succeeds must make an application of the scientific principles,— the day of the careless, haphazard unthinking feeder is past.

Some may argue that the "old cow" herself is the one to select the kind and amount of her ration, since she knows what she likes best and can tell when she is filled up. It is true the cow knows what she likes and knows when she is

full, but she does not know what her different feeds cost or how conducive an excess of them is to a bad case of indigestion. The selection of feeds by the cow is not unlike that of the small boy with a lot of green apples and a box of sugar plums. It is just as necessary to control the feeding of the dairy cow as it is to guard the diet of the small boy. Besides regulating the animal's feed, the farmer should be able to mix the different feeds in the right proportions for securing, first a balanced ration, and second the most economical ration. To aid him in doing this the chemist, the physiologist and the feeder have by careful work and experiments compiled various tables showing the composition of feeds, the proportions of them digestible, their relative value and the amounts of them that stock should have every day. The farmer will doubtless ask, "But how am I to use these tables?" The answer is, "Use them just as the good housewife uses her cook book." The cook book is the woman's guide for preparing the rations to be placed on the dinner table and in just the same way the farmer should study and use the feeding tables for preparing the rations to be given to his stock. It is with the purpose in view of giving to the farmer some plain definitions of feeding terms and some practical illustrations of feeding tables and how to use them that this bulletin has been prepared.

SUBSTANCES OF FEEDING STUFFS.

Let us look first at the classes of substances into which the chemist divides feeding stuffs. He tells us that a given feed contains so much water, so much ash, so much protein, so much carbohydrates and so much ether extract or fat. By water he means the amount of moisture which would be driven off from a sample of a given feed when kept for several hours in an oven at the temperature of boiling water. By ash he means the amount of material which is left behind when the feed is burned. This material consists of the mineral elements which have been taken from

the soil, together with whatever sand and dust that has gotten into the feed. By protein he means the amount of various nitrogenous substances. These are found by determining the nitrogen and multiplying the amount by six and one quarter. By carbohydrates he means the starch, sugar, gums, crude fiber, organic acids and a few other substances taken collectively. By ether extract or fat he means the fats, oils, and waxy substances of the feed. The common name for these substances is fat, although the term ether extract is frequently used because in the analysis they are dissolved from the feed with ether. These five different classes of substances or nutrients as they are called are expressed percentagely and the results of analysis indicate the number of pounds of each that are found in 100 pounds of the given feed. It is only to three of these substances, the protein, fat and carbohydrates, that the feeder need attach any importance. The water is important only in showing how much of it is being bought in a given feed. Water is cheap, and other things being equal, moist feeds should be correspondingly low in price. The ash is unimportant because all feeds contain an abundance of it for the needs of the animal body.

COMPOSITION AND DIGESTIBILITY OF FEEDS.

Tables showing the amounts of the different classes of substances just noted are called "composition tables," because they tell us of what a feed is composed. These tables although very important fail to tell us the whole story, because they do not show what proportion of the nutrients in a given feed the animal is able to digest and make use of. It is at this point that the feeder and physiologist come to the aid of the chemist and help to make another set of tables which are called "tables of digestibility." By actual feeding trials in which a careful record of the weights of the animal and the amounts of feed and water given is kept, together with a chemical analysis of the feed and of the excrements and urine of the animal, the propor-

tion of the various nutrients in a feed which the average animal digests can be closely ascertained. This matter of digestibility of feeds is a very important one, since it is only what the animal digests that is going to be of benefit to it. Corn cobs, for example, contain more protein and nearly as much fat as corn silage, but the digestibility of the protein is three times, and of the fat nearly twice, as great in the silage as it is in the cobs. As a result, therefore, of the work of various investigators both in this country and abroad we are able to compile tables showing the digestibility of the different feeding stuffs. In order then to determine the amount of digestible substance, which is the measure of the actual value of a feed, we simply multiply the amount of the nutrients contained in it by the per cent. of those nutrients which is digestible. For instance, it has been found that corn meal contains 9.2 per cent. of protein, that is, in a hundred pounds of corn meal there are 9.2 pounds of protein, and that the average animal is able to digest 68 per cent. of the protein in corn meal; therefore the amount of digestible protein in the corn meal would be 9.2 x 68 per cent., or 6.25 pounds. In computing rations and the value of feeds the digestible nutrients instead of the total nutrients should be considered.

NUTRITIVE RATIO.

The term "nutritive ratio" is used so generally by the student of feeding problems, farmers' institute speakers and the agricultural press that a thorough understanding of its meaning is necessary for all farmers who are trying to feed on a rational scientific basis. By nutritive ratio is meant the ratio or proportion of the digestible protein to the digestible carbohydrates and fat in any given feed or mixture of feeds. It is found by multiplying the amount of digestible fat by 2.25 and adding the product to the amount of digestible carbohydrates and dividing the sum by the amount of digestible protein. The result will be the number of pounds of digestible carbohydrates and fat

for each pound of digestible protein. The reason for multiplying the fat by 2.25 is because it has two and a quarter times the fuel value of the carbohydrates and before adding must be brought to a carbohydrate basis. For example, let us find the nutritive ratio of clover hay, which has been found to contain 6.8 per cent. digestible protein, 35.8 per cent. digestible carbohydrates, and 1.7 per cent. digestible fat.

$1.7 \times 2.25 = 3.82$	The nutritive ratio of clover hay
$3.82 + 35.9 = 39.72$	then is 1 to 5.8, the protein being
$39.72 \div 6.8 = 5.8$	expressed as 1.

When the proportion of carbohydrates and fat to the protein is large, the ration is said to be "wide," and when it is small the ration is "narrow." Timothy hay, for example, has a ratio of 1 to 16.7, which is wide; gluten feed has a ratio of 1 to 2.6, which is narrow; while clover hay has a ratio of 1 to 5.8, which is medium. The feeds or rations with a narrow nutritive ratio are as a rule more expensive than those with a wide one, because protein or nitrogen, whether purchased as a feed, a fertilizer or as beef steak, always commands a high price.

FEEDING STANDARDS.

Besides having the results of the chemical analyses of feeds and the digestion experiments, we have also the determinations which actual feeding trials have given regarding the amount of protein, carbohydrates and fat which the different classes of animals require under various conditions. An expression of these amounts constitutes what is called a "feeding standard," and is to be used as a guide in computing the rations and their nutritive ratio for animals doing a certain amount of work. These standards are merely the results of experiments and practical experience condensed into a brief statement of what in general, and under average conditions, constitutes a good ration for the purpose in view. They may not be absolutely exact and reliable for each individual animal, neither may they be

the best for a given set of conditions, financial conditions included, but they nevertheless have an importance as a matter of guidance which the careful feeder cannot afford to ignore.

In Table IV is given some standards showing the digestible nutrients required daily by farm animals per 1,000 pounds of live weight.

BALANCED AND MAINTENANCE RATION.

Another feeding term frequently used is "balanced ration." By this is meant a ration in which the protein, carbohydrates and fat are in the proper proportion for the purpose intended. For instance, a ration which is balanced for a working horse would not be balanced for a dry cow, and that for a dry cow would not be balanced for a cow giving ten quarts of milk per day. A "maintenance" ration is one containing just enough nutrients to maintain the animal in good health without gain or loss in weight. It is, however, from the food over and above that required for maintenance that the profit comes to the feeder. From 18 to 20 pounds of dry matter per 1,000 pounds of live weight is required daily by horses and cattle for maintenance. The amount over and above that which can be profitably used will vary with the individual animal. Most animals will give a return in proportion to the food consumed up to a certain limit, although some animals can and do pass through their bodies a considerable amount of food of which no use whatever is made. It is here that the "eye" of the feeder must be used to determine just what amount of food is being profitably used and what is merely being eaten by the animal. From 6 to 10 pounds of dry matter above that required for maintenance can be used by the average animal daily. The term "dry matter" in this connection does not mean the total weight of feed used, but means the total weight of the feed after the amount of water it contains has been deducted. On account of the widely varying amounts of water in the different feeds,

like corn meal and silage, for example, it is necessary to reduce them to a common basis for reckoning their feeding weights and the dry matter is used for this purpose.

BULK IN THE RATION.

Next to the proper nutritive ratio and amount of a ration, its bulkiness must be considered. A certain amount of bulk in the ration is necessary and desirable, and is made up largely by the water and fiber. If the ration is too bulky, the animal is unable to eat enough of it to secure the proper amount of digestible nutrients, and if it is not bulky enough the digestive organs are not sufficiently distended to permit of complete digestion. When the bulk is largely due to fiber, the ration is likely to be too unpalatable to be readily eaten, and when it is due to water a loosening and depleting effect on the system is likely to result. Under ordinary conditions for cattle the ration will be sufficiently bulky when two thirds of the dry matter given is in the form of hay, fodder or silage and one third in the form of grain or concentrated feed. For working horses the amount of grain and coarse feed should be about equally divided.

PALATABILITY OF A RATION.

The palatableness of a ration, or the relish with which it is eaten, is a matter of no little importance. All green succulent feeds are more or less palatable and this is one reason why roots and silage are so valuable and popular as feeds. In general, animals will do better on a ration which suits their taste even though it is not balanced according to the standard, than they will on one which is perfectly balanced that they do not like. The palatability of the feed and the individual whims of the animal frequently necessitate variations from the standards, which, as before stated, are not absolute, and it is here again that the skill of the feeder must be exercised in determining just how great the variations may be.

TABLE I.

COMPOSITION OF SOME COMMON FEEDS.

Kind of Feed.	Water.	Ash.	Protein.	Carbohydrates.	Fat.
Fodders.					
[1] Timothy hay	13.2	4.4	5.9	74.	2.5
[1] Clover hay	15.3	6.2	12.3	63.	3.3
[2] Mixed hay	12.9	5.5	10.1	69.	2.6
[3] Oat hay	8.9	6.2	7.6	74.4	2.9
[3] Oat and pea hay	11.5	6.6	14.8	63.8	3.3
[3] Hungarian hay	16.5	5.6	8.2	66.5	3.2
[2] Swamp hay	11.6	6.7	7.2	72.5	2.0
[3] Rowen (mixed)	16.6	6.8	11.6	62.0	3.1
[3] Rowen (clover)	8.3	7.1	13.1	69.2	2.3
[2] Oat straw	9.2	5.1	4.0	79.4	2.3
[3] Corn stover	40.1	3.4	3.8	51.6	1.1
[4] Corn silage	80.5	1.5	1.6	15.8	0.6
[3] Clover silage	72.0	2.6	4.2	20.0	1.2
Grains.					
[3] Corn meal	15.0	1.4	9.2	70.6	3.8
[3] Corn and cob meal	15.1	1.5	8.5	71.4	3.5
[3] Bran	11.9	5.8	15.4	63.0	4.0
[5] Middlings	10.3	3.3	19.0	62.3	5.1
[3] Oats	11.0	3.0	11.8	69.2	5.0
[3] Wheat	10.5	1.8	11.9	73.7	2.1
[5] Gluten feed	8.6	1.2	26.3	60.3	3.6
[5] Gluten meal	8.8	.7	35.5	52.0	3.1
[3] Hominy chop	8.4	2.6	11.3	69.8	7.9
[6] Brewers' grains	8.0	3.8	23.1	60.2	4.9
[6] Malt sprouts	11.0	5.8	27.1	54.5	1.6
[5] Linseed meal, N. P.	10.1	5.8	33.2	48.0	3.0
[3] Cottonseed meal	8.3	6.9	45.4	28.2	11.2
Miscellaneous.					
[2] Sugar beets	86.5	0.9	1.8	10.7	0.1
[2] Mangels	90.9	1.1	1.4	6.4	0.2
[2] Turnips	90.5	0.8	1.1	7.4	0.2
[3] Pasture grass	80.0	2.0	3.5	10.1	0.8
[3] Skim milk	90.6	0.7	3.1	5.3	0.3

[1] Jenkins and Winton, "Composition of American Feeding Stuffs."
[2] Henry's "Feeds and Feeding."
[3] Bull. 81, Vt. Experiment Station.
[4] N. H. Exp. Sta. Analysis.
[5] Compiled from Feed Inspection Reports.
[6] Hatch Exp. Sta. Bull. No. 94.

TABLE II.

PERCENTAGE DIGESTIBILITY OF FEEDS.

Kind of Feed.	Protein.	Carbohydrates.	Fat.
Fodders.			
[1] Timothy hay	48	59	57
[1] Clover hay	55	57	53
[1] Mixed hay	58	59	48
[2] Oat hay	54	49	62
[2] Oat and pea hay	76	65	68
[1] Hungarian hay	60	67	64
[3] Swamp hay	34	41	44
[2] Rowen (mixed)	69	66	47
[2] Rowen (clover)	65	56	60
[2] Oat straw	30	55	38
[1] Corn stover	52	57	52
[1] Corn silage	52	70	85
[2] Clover silage	65	56	60
Grains.			
[2] Corn meal	68	95	92
[2] Corn and cob meal	56	84	84
[2] Bran	78	56	68
[2] Middlings	80	81	86
[2] Oats	78	68	83
[3] Wheat	86	94	81
[2] Gluten feed	85	87	84
[2] Gluten meal	88	90	94
[2] Hominy chop	77	94	81
[1] Brewers' grains	79	56	91
[1] Malt sprouts	80	62	100
[2] Linseed meal, N. P	85	85	97
[2] Cottonseed meal	88	60	93
Miscellaneous.			
[1] Sugar beets	91	100	50
[1] Mangels	75	70	.....
[1] Turnips	90	98	98
[1] Pasture grass	70	74	63
[2] Skim milk	94	98	100

[1] Report Hatch Exp. Sta. 1896.
[2] Vt. Exp. Sta. Bull. No. 81.
[3] Henry's "Feeds and Feeding."

[1]TABLE III.

NUTRIENTS IN 100 LBS. OF FEED.

Kind of Feed.	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	
Fodders.					
Timothy hay	86.8	2.8	43.6	1.4	1 to 16.7
Clover hay	84.7	6.8	35.9	1.7	1 to 5.8
Mixed hay	87.1	5.9	40.7	1.2	1 to 7.4
Oat hay	91.1	4.1	36.5	1.8	1 to 9.9
Oat and pea hay	88.5	11.2	41.5	2.2	1 to 4.1
Hungarian hay	83.5	4.9	44.5	2.0	1 to 10.
Swamp hay	88.4	2.4	29.7	0.9	1 to 13.2
Rowen (mixed)	83.4	8.0	40.9	1.5	1 to 5.5
Rowen (clover)	91.7	8.5	38.8	1.4	1 to 4.9
Oat straw	90.8	1.2	43.7	0.9	1 to 38.0
Corn stover	59.9	2.0	29.4	0.6	1 to 15.4
Corn silage	19.5	0.8	11.0	0.5	1 to 15.2
Clover silage	28.0	2.7	11.2	0.7	1 to 4.7
Grains.					
Corn meal	85.0	6.3	67.0	3.5	1 to 11.9
Corn and cob meal	84.9	4.8	60.0	2.9	1 to 13.8
Bran	88.1	12.0	35.3	2.7	1 to 3.4
Middlings	89.7	15.2	50.5	4.4	1 to 4.0
Oats	89.0	9.2	47.1	4.1	1 to 6.1
Wheat	89.5	10.2	69.3	1.7	1 to 7.2
Gluten feed	91.4	22.6	52.5	3.0	1 to 2.6
Gluten meal	91.2	31.2	46.8	2.9	1 to 1.7
Hominy chop	91.6	8.7	65.6	6.4	1 to 9.2
Brewers' grains	92.0	18.2	33.7	4.5	1 to 2.4
Malt sprouts	89.0	21.7	33.8	1.6	1 to 1.7
Linseed meal, N. P.	89.9	28.2	40.8	2.9	1 to 1.7
Cottonseed meal	91.7	39.9	16.9	10.4	1 to 1.0
Miscellaneous.					
Sugar beets	13.5	1.6	10.7	.....	1 to 6.7
Mangels	9.1	1.0	4.5	0.1	1 to 4.7
Turnips	9.5	1.0	7.3	0.2	1 to 7.7
Pasture grass	20.0	2.5	7.5	0.5	1 to 3.4
Skim milk	9.4	2.9	5.2	0.3	1 to 2.0

[1] Compiled from Tables I and II according to directions on page 190.

[1] TABLE IV.

STANDARDS SHOWING WHAT STOCK REQUIRE DAILY.

Per 1,000 lbs. live weight.	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	
Cows giving 10 qts. per day	24 lbs.	2.4 lbs.	13.0 lbs.	.6	1 to 6.
Dry cows	20 "	1.0 "	10.0 "	.2	1 to 10.5
Working oxen	25 "	2.0 "	11.5 "	.5	1 to 6.5
Horses, medium work	22 "	2.0 "	11.0 "	.6	1 to 6.2
Swine, fattening	32 "	4.0 "	24.0 "	.5	1 to 6.3
Sheep, ordinary	21 "	1.3 "	11.5 "	.3	1 to 9.4

[1] Compiled from various standards.

USING THE TABLES.

After briefly reviewing some of the facts and principles of feeding, we are now in a position to look at some tables and make use of our "cook book." Tables I and II are of interest in showing how our common feeds vary in composition and digestibility. It may be mentioned at this point that the figures given in these tables are the average of a large number of analyses, varying from 3 to 100 or more, and that they may not exactly agree with any separate analysis the feeder may chance to have made, or with those reported in other bulletins of this station. These are averages, and it is with average feeds and conditions of feeding that this discussion is attempting to deal. Table III, which shows the amounts of dry matter and digestible nutrients in the feeds, has been derived from Tables I and II, and it is the figures in this table which will be used in the following computations. The matter of computing rations is not at all difficult, requiring only the use of simple arithmetic, including decimals and percentage. The object is to secure a mixture of feeds which will correspond in the amounts of dry matter and digestible nutrients which it contains, to the standard which experience has found best for the given purpose in view.

Let us for example compare a given ration with a standard. Take a 900-pound milch cow giving 10 quarts per day, and assume she is receiving the following ration:

10 pounds clover hay,
30 pounds corn silage,
4 pounds corn meal,
4 pounds bran.

Looking at Table III, we see that 100 pounds of clover hay contains 84.7 pounds of dry matter, 6.8 pounds of digestible protein, 35.9 pounds digestible carbohydrates and 1.7 pounds digestible fat. If 100 pounds of the hay contain these amounts, 10 pounds must contain 8-100 of them. To calculate this, divide the amount given by 100 and multiply by 10. Thus:

84.7÷100×10=8.47 pounds dry matter.
6.8÷100×10=0.68 pounds digestible protein.
35.9÷100×10=3.59 pounds digestible carbohydrates.
1.7÷100×10=0.17 pounds digestible fat.

By the table 100 pounds of corn silage contains 19.5 pounds dry matter, 0.8 pounds digestible protein, 11.0 pounds digestible carbohydrates and 0.5 pounds digestible fat. In this case we divide the amount by 100 and multiply by 30, as follows:

19.5÷100×30=5.85 pounds dry matter.
0.8÷100×30=0.24 pounds digestible protein.
11.0÷100×30=3.30 pounds digestible carbohydrates.
0.5÷100×30=0.15 pounds digestible fat.

Using Table III in the same way for corn meal and bran, we find the four pounds of corn meal to contain:

85.0÷100×4=3.40 pounds dry matter.
6.3÷100×4=0.25 pounds digestible protein
67.0÷100×4=2.68 pounds digestible carbohydrates.
3.5÷100×4=0.14 pounds digestible fat.

and the four pounds of bran to contain:

88.1÷100×4=3.52 pounds dry matter.
12.0÷100×4= .48 pounds digestible protein.
35.3÷100×4=1.41 pounds digestible carbohydrates.
2.7÷100×4= .11 pounds digestible fat.

Next, adding together the amounts of dry matter and digestible nutrients in the four feeds, we find the total in the ration, which may then be compared with the standard:

	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbohydrates.	Fat.	
10 lbs. clover hay	8.47	.68	3.59	.17	
30 lbs. corn silage	5.85	.24	3.30	.15	
4 lbs. corn meal	3.40	.25	2.68	.14	
4 lbs. bran	3.52	.48	1.41	.11	
Total	21.24	1.65	10.98	.57	1 to 7.4
Standard for 900-lb. cow	21.60	2.16	11.70	.54	1 to 6.0

The standards given in Table IV are for 1,000 pounds of live weight, but in the case assumed, the cow weighs only 900 pounds, so there must be a corresponding reduction of the amounts in the standard. The reduction is calculated just as the feeds were above; if a 1,000-pound cow requires 24 pounds of dry matter, a 900-pound cow will require $24 \div 1{,}000 \times 900 = 21.6$ pounds. The amount of protein, carbohydrates and fat for the 900-pound cow are calculated in exactly the same way from the standard.

In comparing the ration assumed with the standard, we find it deficient in all the nutrients except the fat, and especially low in protein. In order to correct this we will add one pound of cottonseed meal to the mixture and see how it affects it. Using Table III just as we did for the other feeds, we find that the one pound of cottonseed meal contains:

$91.7 \div 100 \times 1 = .91$ pounds dry matter.
$39.9 \div 100 \times 1 = .40$ pounds digestible protein.
$16.9 \div 100 \times 1 = .17$ pounds digestible carbohydrates.
$10.4 \div 100 \times 1 = .10$ pounds digestible fat.

Again adding together the amounts of dry matter and digestible nutrients in the feeds used, we find our ration to be as follows:

	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	
10 lbs. clover hay	8.47	.68	3.59	.17	.....
30 lbs. corn silage	5.85	.24	3.30	.15	.....
4 lbs. corn meal	3.40	.25	2.68	.14	.....
4 lbs. bran	3.52	.48	1.41	.11	.....
1 lb. cottonseed	.91	.40	.17	.10	.....
Total	22.15	2.05	11.15	.67	1 to 6.1
Standard for 900-lb. cow..	21.60	2.16	11.70	.54	1 to 6.0

The ration now corresponds as closely to the standard as could be reasonably expected in practice. It must not be understood, however, that this is the *best* or *only* combination of feeds which a 900-pound cow giving 10 quarts of milk daily, should receive. It is only *one* combination which meets the requirements of the standard, and for convenience in some following calculations, we will call it sample ration No. 1.

Any other ration can be worked out in exactly the same manner as the preceding, and in order for the reader to familiarize himself with the process it is suggested that he work out sample ration No. 1 independently and then compare his results with those given. Most feeders can make pretty close estimates of the live weights of cattle, but in order to aid them in this if no scales are available, a table based on girth measurement is given on the following page.

TO MAKE UP A RATION.

Take 1 to 1½ per cent. of live weight for the amount of hay and about 4 per cent. of the live weight for the amount of silage, and in any case enough fodders or roughage to make up about two thirds of the dry matter. Using some of the common coarse feeds which the average farmer is likely to have on hand we will make up some "foundation" rations for a 900-pound cow, and from Table III calculate what they contain.

		Dry matter.	Digestible.		
			Protein.	Carbo-hydrates.	Fat.
Foundation Ration No. I	10 lbs. clover hay...	8.47	.68	3.59	.17
	30 lbs. silage.....	5.85	.24	3.30	.15
Total..		14.32	.92	6.89	.32
Foundation Ration No. II	8 lbs. clover hay...	6.77	.54	2.87	.14
	12 lbs. corn stover..	7.20	.24	3.52	.07
Total..		13.97	.78	6.39	.21
Foundation Ration No. III	8 lbs. mixed hay...	6.97	.47	3.26	.10
	8 lbs. oat hay.....	7.29	.33	2.92	.14
Total..		14.26	.80	6.18	.24
Foundation Ration No. IV	8 lbs. mixed hay...	6.97	.47	3.26	.10
	40 lbs. silage.....	7.80	.32	4.40	.20
Total..		14.77	.79	7.66	.30

[1]TABLE FOR ESTIMATING LIVE WEIGHT OF CATTLE.

Heart girth in feet and inches.		Store cattle.		Medium fat.	
		Fair shape.	Good shape.	Fair shape.	Good shape.
Feet.	Inches.	Pounds.	Pounds.	Pounds.	Pounds.
5	0	650	700	700	750
5	1	675	725	725	775
5	2	700	750	750	800
5	3	725	775	775	825
5	4	750	800	800	850
5	5	775	825	825	875
5	6	800	850	850	900
5	7	825	875	875	925
5	8	850	900	900	950
5	9	875	925	925	975
5	10	900	950	950	1000
5	11	925	975	975	1025
6	0	950	1000	1000	1050
6	1	1000	1050	1050	1100
6	2	1050	1100	1100	1150
6	3	1100	1150	1150	1200
6	4	1150	1200	1200	1250
6	5	1200	1250	1250	1300
6	6	1250	1300	1300	1350
6	7	1300	1350	1350	1400
6	8	1350	1400	1400	1450
6	9	1400	1450	1450	1500
6	10	1450	1500	1500	1550
6	11	1500	1550	1550	1600
7	0	1550	1600	1600	1650
7	1	1600	1650	1650	1700
7	2	1650	1700	1700	1750
7	3	1700	1750	1750	1800
7	4	1750	1800	1800	1850
7	5	1800	1850	1850	1900
7	6	1850	1900	1900	1950

[1] Reprinted from Bulletin No. 17.

Foundation ration No. I has already been adjusted with certain grains to make up sample ration No. 1. We will now adjust it again, using a different combination of grains into sample ration No. 2.

	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	
10 lbs. clover hay	8.47	.68	3.59	.17	
30 lbs. silage	5.85	.24	3.30	.15	
3 lbs. corn meal	2.55	.19	2.01	.10	
2 lbs. gluten feed	1.83	.45	1.05	.06	
2 lbs. middlings	1.79	.30	1.01	.09	
1 lb. linseed meal	.90	.28	.41	.03	
Total	21.39	2.14	11.37	.60	1 to 6.0
Standard	21.60	2 16	11.70	.54	1 to 6.0

Foundation ration No. II may be adjusted into sample ration No. 3, as follows:

	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	
8 lbs clover hay	6.77	.54	2.87	.14	
12 lbs. corn stover	7.20	.24	3.52	.07	
3 lbs. hominy chop	2.75	.26	1.97	.19	
3 lbs. middlings	2.69	.45	1.52	.13	
3 lbs. gluten feed	2.74	.68	1.58	.09	
Total	22.15	2.17	11.46	.62	1 to 5.9
Standard	21.60	2.16	11.70	.54	1 to 6 0

Taking foundation ration No. III and adjusting it with a mixture of grains, we will have sample ration No. 4:

	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbo-hydrates.	Fat.	
8 lbs. mixed hay	6.97	.47	3.26	.10	
8 lbs. oat hay	7.29	.33	2.92	.14	
4 lbs. corn meal	3.40	.25	2.68	.14	
2 lbs. hominy chop	1.83	.17	1.31	.13	
3 lbs. gluten meal	2.74	.94	1.40	.09	
Total	22.23	2.16	11.57	.60	1 to 6
Standard	21.60	2.16	11.70	.54	1 to 6

By adjusting foundation ration No. IV with certain grains, we have the following sample ration No. 5:

	Dry matter.	Digestible.			Nutritive ratio.
		Protein.	Carbohydrates.	Fat.	
8 lbs. mixed hay	6.97	.47	3.26	.10	
40 lbs. silage	7.80	.32	4.40	.20	
3 lbs. ground oats	2.67	.28	1.41	.12	
3 lbs. brewers' grains	2.76	.55	1.01	.14	
2 lbs. bran	1.76	.24	.71	.05	
1 lb. linseed meal	.90	.28	.41	.03	
Total	22.86	2.14	11.20	.64	1 to 5.9
Standard	21.60	2.16	11.70	.54	1 to 6.0

COST OF RATIONS.

The cost of the five sample rations just given may be computed from the following average local prices for roughage and from the average prices of the grain feeds in one-ton lots, at Concord, N. H.:

Roughage	Mixed hay	$10.00 per ton.
	Clover hay	10.00 per ton.
	Oat hay	8.00 per ton.
	Corn stover	3.50 per ton.
	Corn silage	3.00 per ton.
Grains	Bran	$22.00 per ton.
	Brewers' grains	21.00 per ton.
	Corn meal	24.00 per ton.
	Cottonseed meal	30.00 per ton.
	Gluten feed	28.00 per ton.
	Gluten meal	30.00 per ton.
	Ground oats	27.50 per ton.
	Hominy chop	23.00 per ton.
	Linseed meal	31.50 per ton.
	Middlings	26.00 per ton.

At the above prices, the cost of sample ration No. 1 would be:

For 10 pounds clover hay,	10× .5	=5.0 cents.
For 30 pounds corn silage,	30× .15	=4.5 cents.
For 4 pounds corn meal,	4×1.2	=4.8 cents.
For 4 pounds bran,	4×1.1	=4.4 cents.
For 1 pound cottonseed meal,	1×1.5	=1.5 cents.
Total per day,		20.2 cents.

The cost of the other rations calculated in the same manner would be:

For sample ration No. 2,	20.08 cents.
For sample ration No. 3,	17.65 cents.
For sample ration No. 4,	18.8 cents.
For sample ration No. 5,	20.98 cents.

It will be noticed that the cost of rations 3 and 4 is a little lower than that of 1, 2 and 5. Hominy chop constitutes a part of both the former and is largely responsible for the lower cost. At the present prices of this feed it would pay our farmers to take it into consideration in making up their rations. Of course the prices used in the above computations are only average, and will vary somewhat at different seasons and in different localities. The farmer, however, should be on the alert and watch these variations, and by a few simple calculations like those on the preceding pages he can easily determine what would constitute the cheapest balanced ration for him to feed.

MIXTURES OF FEEDS.

Instead of weighing out separately the given amounts of each different kind of grain, it is more convenient to make mixtures of them and then weigh out the required amount of the mixture. Taking the grains in the five sample rations previously worked out, we can make up five mixtures suitable for the dairy cow when being fed on the kinds of roughage given in the "foundation" rations.

Grain mixture No. 1 { 400 pounds corn meal; 400 pounds bran; 100 pounds cotton seed meal } Amount for 900-pound cow, 9 lb.

Roughage—Clover hay and corn silage.

Grain mixture No. 2 — Amount for 900-pound cow, 8 lb.
- 300 pounds corn meal
- 200 pounds gluten feed
- 200 pounds middlings
- 100 pounds linseed meal

Roughage—Clover hay and corn silage.

Grain mixture No. 3 — Amount for 900-pound cow, 9 lb.
- 300 pounds hominy chop
- 300 pounds middlings
- 300 pounds gluten feed

Roughage—Mixed hay and corn stover.

Grain mixture No. 4 — Amount for 900-pound cow, 9 lb.
- 400 pounds corn meal
- 300 pounds gluten meal
- 200 pounds hominy chop

Roughage—Mixed hay and oat hay.

Grain mixture No. 5 — Amount for 900-pound cow, 9 lb.
- 300 pounds ground oats
- 300 pounds brewers' grains
- 200 pounds bran
- 100 pounds linseed meal

Roughage—Mixed hay and corn silage.

For cows of a greater or less weight than 900 pounds a proportionately greater or less weight of the mixture should be fed.

It is frequently more convenient, although somewhat less accurate, to measure rather than weigh out the various amounts of grain mixtures. Since the quart is a common and suitable unit of measure for this purpose on the farm, the following table has been prepared to show the average weight of one quart and the amount of one pound of different feeding stuffs.

Name of feed.	Weight of one quart.	Measure of one pound.
Bran	.5 lbs.	2.0 qts.
Brewers' grains	.6 "	1.7 "
Corn and cob meal	1.3 "	.8 "
Corn meal	1.4 "	.7 "
Corn, whole	1.7 "	.6 "
Cottonseed meal	1.5 "	.7 "
Gluten feed	1.3 "	.8 "
Gluten meal	1.7 "	.6 "
Hominy chop	1.2 "	.8 "
Linseed meal, N. P.	1.1 "	.9 "
Malt sprouts	.6 "	1.7 "
Middlings	1.0 "	1.0 "
Oats, ground	.8 "	1.3 "
Oats, whole	1.2 "	.8 "
Oat middlings	1.5 "	.7 "
Wheat, ground	1.7 "	.6 "
Wheat, whole	1.9 "	.5 "
Union grains	1.0 "	1.0 "

Using the figures in the above table, we can easily compute the number of quarts in any given weight of feed or mixture of feeds.

For example, take the following:

9 pounds of grain mixture No. 1=11.5 quarts.
8 pounds of grain mixture No. 2= 6.6 quarts.
9 pounds of grain mixture No. 3= 7.8 quarts.
9 pounds of grain mixture No. 4= 6.2 quarts.
9 pounds of grain mixture No. 5=13.9 quarts.

It will be noticed that when bran, brewers' grains, ground oats or other comparatively bulky grain feeds enter into the ration a larger measure of the feed is required. In so far as possible the ration should be made up so that the more bulky grain part goes with the less bulky roughage part. For example, grain mixture No. 2 is better adapted to "foundation" ration No. I, which contains silage, than is grain mixture No. 1, so far as bulk is concerned. For the same reason, another grain mixture than No. 5 would be better adapted to "foundation" ration No. IV, which is already rather bulky on account of the silage.

The question of how far silage can be made to replace grain in a ration for the dairy cow without injuriously affecting either her health or the quality of the milk is the one of economic importance to the New Hampshire farmer.

A series of experiments bearing on the above question is now in progress at this Station and some interesting results are anticipated.

SUMMARY.

(1) The economic feeding of stock should be the feeder's primary object.

(2) Economic feeding must go hand in hand with scientific feeding.

(3) The principles of scientific feeding have been carefully worked out by skilled investigators and feeders.

(4) The application of these scientific principles is a

very simple process involving only the rules of common arithmetic.

(5) Every farmer can and should apply these principles in his everyday practice.

(6) A careful study of the market prices on feeds and an inspection of their guarantee tags will mean money in pocket to the farmer.

PUBLICATIONS OF EXPERIMENT STATION.

The following publications of the Station are available for distribution:

No. 2. Feeding Experiments.
No. 3. When to Cut Corn for Ensilage.
No. 4. The Science and Practice of Stock-Feeding.
No. 5. Fertilizers and Fertilizing Materials.
No. 6. Experiments with Fertilizers.
No. 7. Test of Dairy Apparatus.
No. 8. Feeding Experiments. Part 1. Principles of Feeding. Part 2. Corn Meal, Middlings, Shorts, and Cotton-Seed Compared.
No. 11. Pig Feeding. Part 1. Results of Feeding Skim Milk and Corn Meal versus Corn Meal and Middlings. Part 2. Digestion Experiment.
No. 12. Fertilizer Experiments.
No. 14. Ensilage in Dairy Farming.
No. 16. Effect of Food on Composition of Butter Fat.
No. 17. Stock Feeders' Guide.
No. 18. Effect of Food on Milk.
No. 19. Spraying Apples and Pears against Fungi.
No. 20. Effect of Food on Milk. Feeding with Fats.
No. 21. Farmyard Manures and Artificial Fertilizers.
No. 22. Prevention of Potato Blight.
No. 23. Some Dangerous Fruit Insects.
No. 24. The Flow of Maple Sap.
No. 25. The Composition of Maple Sap.
No. 26. Analysis of Fertilizers and Wood Ashes.
No. 27. Spraying Experiments in 1894.
No. 28. Remedies for the Horn Fly.
No. 29. Remedies for Flea Beetles.
No. 30. An Experiment in Road Making.
No. 31. Seventh Annual Report. 1895.
No. 32. Studies of Maple Sap.
No. 33. Two Shade-Tree Pests.
No. 34. Surface and Sub-Irrigation out of Doors.
No. 35. The Codling Moth and the Apple Maggot.
No. 36. Analyses of three Common Insecticides.
No. 37. Crimson Clover.
No. 38. The Tent Caterpillar.
No. 39. The Army Worm.
No. 40. Eighth Annual Report. 1896.
No. 41. Potatoes: Varieties, Fertilizers, Scab.
No. 42. Part 1. Tomato Growing in New Hampshire. Part 2. Notes on Tomato Breeding.
No. 44. The Cankerworm.
No. 45. Fruit and Potato Diseases.
No. 46. Part 1. An Experiment with a Steam Drill. Part 2. Methods of Road Maintenance.
No. 48. Ninth Annual Report. 1897.

No. 53. The Farm Water Supply.
No. 56. Poisonous Properties of Wild Cherry Leaves.
No. 57. Forage and Root Crops.
No. 58. Cost of Raising Calves.
No. 59. Tenth Annual Report. 1898.
No. 60. Green Corn under Glass.
No. 61. Inspection of Fertilizers in 1898.
No. 62. Forcing Pole Beans under Glass.
No. 64. The Forest Tent Caterpillar.
No. 66. Experiments in Pig Feeding.
No. 67. The Spiny Elm Caterpillar.
No. 68. Eleventh Annual Report. 1899.
No. 69. Inspection of Fertilizers in 1898.
No. 70. Experiments with Muskmelons.
No. 71. Corn Culture.
No. 72. Insect Record for 1899.
No. 74. Growing Strawberries in New England.
No. 75. The Forest Tent Caterpillar. Second Report.
No. 76. Utilizing the Greenhouse in Summer.
No. 77. Experiments in Road Surfacing.
No. 78. Bovine Tuberculosis.
No. 79. Twelfth Annual Report. 1900.
No. 80. Inspection of Fertilizers in 1900.
No. 81. Insect Record for 1900.
No. 82. Feeding Farm Horses.
No. 83. Value of Meadow Muck.
No. 84. Forcing Dwarf Tomatoes.
No. 85. Remedies for the Cankerworm.
No. 86. Growing Watermelons in the North. Classification of Watermelons.
No. 87. Thirteenth Annual Report. 1901.
No. 88. Inspection of Fertilizers, 1901, Analyses of Ashes, etc.
No. 89. The Squash Bug.
No. 90. Insect Record for 1901.
No. 91. Killing Woodchucks with Carbon Bisulphide.
No. 92. Silage Studies.
No. 93. The Cold Storage of Apples.
No. 94. Remedies for Fleas.
No. 95. How to Grow a Forest from Seed.
No. 96. Fourteenth Annual Report. 1902.
No. 97. Inspection of Fertilizers. 1902.
No. 98. Inspection of Feeding-Stuffs. 1902.
No. 99. Selected List of Vegetables for the Garden.
No. 100. White-Fly of Greenhouses.
No. 101. Fungous Diseases and Spraying.
No. 102. Insect Record. 1902.
No. 103. Standard Milk.
No. 104. Fifteenth Annual Report. 1903.
No. 105. Fruit Growing. Varieties for N. H.
No. 106. Forestry.
No. 108. Inspection of Fertilizers.
No. 109. San Jose Scale.
No. 110. Orchard Management in New England.
No. 111. Experiments with Potatoes and Potato Culture.
No. 112. Remedies for the Black Fly.
No. 113. Experiments in Pig Feeding.
No. 114. The Babcock Test for N. H. Dairymen.
No. 115. Sixteenth Annual Report. 1904.
No. 116. Inspection of Feeding Stuffs. 1904.
No. 117. Inspection of Fertilizers. 1904.
No. 118. Tile Drainage.
No. 119. Forestry.
No. 120. The Dairy Industry in New Hampshire.
No. 121. The Gypsy Moth in New Hampshire.
No. 122. The Brown-Tail Moth in N. H. Second Report.
No. 123. Inspection of Fertilizers. 1905.
No. 124. Inspection of Feeding-Stuffs. 1905.
No. 125. Vegetable Novelties.
No. 126. The Care of Composite Milk Samples.